Restoration of 100+ Years Old Public Building

Project: Hall of Records, Bakersfield, CA

The Hall of Records is a historic, single-story government building in Bakersfield, California. Original construction was completed in 1910 and the $55,000 building opened its doors in the heart of the Civic Center portion of downtown Bakersfield on the corner of Chester and Truxtun. When it celebrated its centennial in 2009, it remained the longest continuously used government building in Kern County, housing approximately 9.2 million records. During its long life, the Hall of Records has served an ever- increasing population, from its humble beginnings serving a population of 37,000 to Kern County's current population of over 880,000 people. Renovations to the structure occurred in 1939 and again in 1988, along with a seismic retrofit. These changes highlighted the structure's architectural transformation from its original Beaux Arts style to a PWA Modern style.

STRUCTURE CHARACTERISTICS

The entirely cast-in-place concrete building's footprint is approximately 9,300 ft^2 with a partial finished basement and crawl space. The 4" roof slab is supported by a network of pan joist beams and girders.

The 4" floor slab is covered with a non-structural topping and supported by 8" x 21" pan joist beams spanning from the perimeter to interior 12" x 40" girders on a 27' grid. The floor and

roof beams are supported by interior columns with pad footings and perimeter walls or pilasters on continuous footings. A combination of smooth shear dowels and square, twisted flexural reinforcing was noted throughout.

PROBLEMS THAT PROMPTED REPAIR

Signs of concrete deterioration in the approximately 9,000 ft2 unfinished crawl space were noted during the 1988 retrofit, and in 2013 investigations showed that several columns, pilasters, and beams showed signs of severe spalling, delamination, corrosion, and cracking. A more detailed investigation was requested to determine any additional defects in the crawl space concrete and the cause of the reinforcement corrosion.

INSPECTION / EVALUATION METHODS

A multitude of in-situ and laboratory testing ensued, including the following:

- Testing of concrete cores in select elements for material strength in accordance with ASTM C39
- Schmidt Hammer Testing for material strength over a more comprehensive area.

- Impact-Echo and Pulse Velocity testing in accordance with ASTM C 1383 and ASTM C 597 to locate additional defects in the concrete
- Limited geotechnical investigation to determine the resistivity, pH, and the soluble sulfate and chloride content of the soil in accordance with ASTM G 57, ASTM D 4972, and ASTM D 4372 (respectively)
- Half-cell corrosion potential testing in accordance with ASTM C 876 (at the site)
- Acid Soluble Chloride Analysis, Carbonation, Concrete pH, and Microscopic Evaluation (on concrete cores).

- The tests showed the concrete strength to be typical for its vintage with no significant internal voids or delamination. The visually active corrosion locations were substantiated by the tests and the cause of the corrosion was deemed to be both inherent in the concrete and further exacerbated by the corrosive soil. The soil samples taken from inside the crawl space indicated an average resistivity of 592 ohm-cm, a pH of 9.06, average chloride content of 679 mg/kg with a maximum of 2,500 mg/kg, and an average water-soluble sulfate content of 1,009 mg/kg with a maximum of 6,100 mg/kg. The clearly corrosive soil left its mark on the concrete, with the chloride content of the concrete ranging from 0.07 to 16 lb/cu yd of concrete. The pH of the concrete ranged from 9.5 to 11. The depth of carbonation reached from 1- inch depth in the footings to over 4-inch depth in the columns, beams, and walls.

CAUSES OF DETERIORATION

Over the years, the high chloride and sulfate content in the soil migrated into the concrete. It is also highly possible that the original concrete mix used calcium chloride as an admixture. Given the vintage, the concrete was probably mixed in small batches and contributed to the uneven, high chloride content of select beams and columns above the soil. The extensive carbonation of the concrete, beyond the depth of the concrete cover, has accelerated the corrosion of the reinforcing.

REPAIR SYSTEM SELECTION

The repair option selected by the Owner consisted of repairing the corroded reinforcing and spalled concrete, inhibiting future corrosion, bringing the damaged members back to their original design strength, and separating the corrosive soil from the concrete in the crawl space.

SITE PREPARATION / UNFORESEEN CONDITIONS

In order to prepare the site for construction over 9,300 pounds of trash and unused conduit/cabling had to be removed from the crawl space. The cramped conditions were finally fully illuminated when the contractor installed lighting, exposing 231 additional spalls in the ceiling and walls, the majority of which required repair. Numerous holes had been drilled into or through the first floor concrete slab during the Hall of Record's lifetime and little care had been taken to avoid the existing reinforcing in the slab. The spalls and corroded reinforcement were repaired in a similar fashion to the beam and columns. The vibrations and movements during construction in the crawl space exposed the extent of severely

deteriorated sewage pipes with insufficient joint connections, some of which were found to be leaking. The Contractor took on the additional plumbing scope and was able to move forward with the concrete and plumbing repair items simultaneously, mitigating negative effects to the overall schedule.

Additional water intrusion to the crawl space was discovered along the southern side of the building, where the moisture appears to be originating from the soil directly behind the wall. Investigations are currently ongoing to determine the intrusion's source and stop it at the time this report was written.

DEMOLITION METHOD

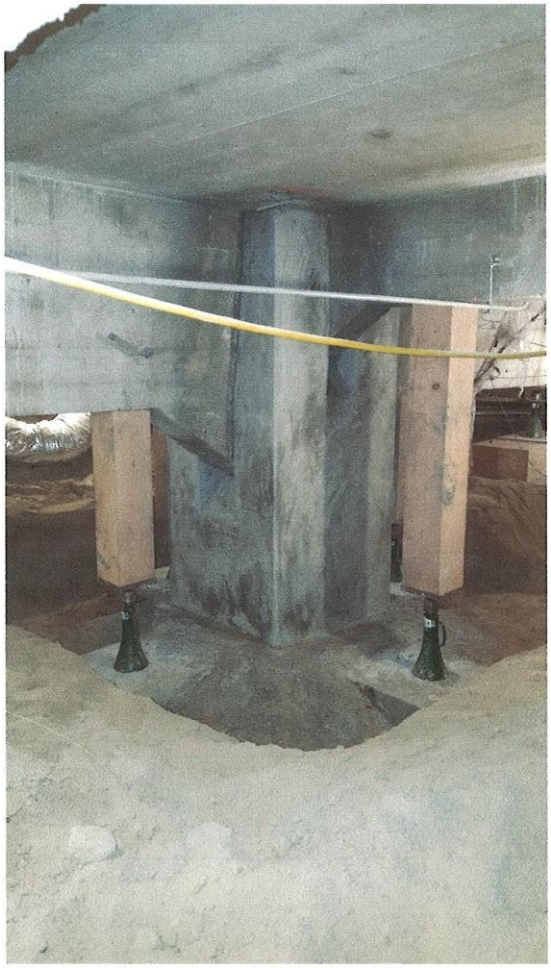
The majority of the demolition was performed using air pneumatic guns with chisel points. Electric rotary hammers were utilized to clear the concrete behind the reinforcing and the reinforcing was cleaned using angle grinders with wire wheel attachments and sand blasting. The depth of the concrete needing to be removed for the repair exceeded the anticipated ranges for (2) interior columns, prompting a need for shoring as the 24" square columns were whittled down to almost 14" square columns.

SURFACE PREPARATION / APPLICATION METHOD SELECTION / REPAIR PROCESS EXECUTION

The surface was prepared with electric rotary hammers to roughen the repair area. Embedded galvanic anodes encased in a highly alkaline cementitious shell were installed on the existing reinforcing to prevent any further corrosion. The exposed reinforcing was coated with a 3-component, epoxy- modified, cementitious, anti-corrosion coating while the exposed concrete was coated with an epoxy resin/Portland cement adhesive bonding bridge. Additional longitudinal and transverse reinforcing was epoxy-doweled into the structure outside of the original reinforcement cage to replace the reinforcement lost to corrosion. New flyash and

silica fume enhanced shotcrete was applied to not only re-build the original cross section, but also tie the protective reinforced concrete "jacket" to the existing member's core and provide an additional 3" clearance to the new reinforcing to further retard the onset of additional corrosion. The rebuilding of the cross-sections occurred at the locations with severe spalling and corrosion. The finished product and existing concrete that did not require repair was then separated from the corrosive soil by (2) layers of 15 mil vapor barrier extending from the top of the

existing footings to 3'-0" above the top of soil. This cost-effective solution further encapsulates the soil and stops the chlorides in the soil from continuing to migrate into the surrounding concrete. Further options to reduce the accumulation of moisture in the crawl space are being investigated, including the installation of louvers or installing an additional (2) layers of 15 mil vapor barrier extended across the top of the leveled soil.



SPECIAL FEATURES

The close, collaborative relationship between the Owner, Structural Engineer, Contractor, and Materials Science Engineer enabled the project to be substantially completed on time and in a cost-effective fashion. The majority of the work was completed after normal business hours as the Hall of Records maintained its normal hours of operations during the entire course of construction. Determining and mitigating the cause of the spalling and corrosion, coupled with properly repairing the damage accumulated over 100 years, has given the structure a new lease on life and the Owner a building that will continue to safely serve the public for many more years to come.